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Chemical-Process Recycling Promise to Become Important "closed-loop" Reclaim Technology

Process and Developer ^a	Concept ; Remarks	Targeted Feedstock ^b	Commercial Status ^c
DEPOLYMERIZATION			
Condensation/Reaction-Type Polymers^d			
<i>Hydrolysis</i>			
General Motors, Detroit, MI	Twin-screw extruder converts PUR to polyol.	4	E
<i>Glycolysis</i>			
Goodyear, Akron, OH	Partial breakdown of polyethylene terephthalate to monomers for reuse.	1	C
Mobay, Pittsburgh, PA	Polyol is produced for reuse at 10-20% replacement of virgin content.	4	E
Institute of Technology, Aalen, Germany	Automotive seats glycolized into high-viscosity polyols for use in rigid PUR foams.	7	E
<i>Methanolysis</i>			
Du Pont, Wilmington, DE	Full PET breakdown to monomer for reuse.	2	D
Eastman Kingsport, TN	Search for innovative, more cost effective methanolysis.	2	D
Hoechst Celanese, Charlotte, NC	Full PET breakdown to monomer for reuse.	1	C
<i>Transesterification^e</i>			
Oxid, Houston, TX	Reduces PET to monomer for repolymerization into polyols used in polyisocyanurate foam.	2	C
Synergistics, Industries, St-Remi, QUE	Degrades PET in conventional esterification unit into plasticizer for PVC.	2	D
Addition-Type Polymers^f			
Battelle Labs, Columbus, OH	Dedicated process unit breaks plastic down to monomer for "closed-loop" reuse.	3	D
Solar Energy Research Institute, Golden, CO	Dedicated process depolymerizes plastic waste to recover monomers.	3	D
Tokyo Institute of Technology, Tokyo, Japan	Fluidized bed of silica sand yields 80% combustible methane and ethylene gases.	5	E
REFINERY RECYCLING			
Amoco Chemicals, Chicago, IL	Refinery cracking : conversion of plastic waste to hydrocarbons.	3	D
Chevron Chemical and Mobil Chemical, Houston, TX	Refinery coking : conversion of plastic waste to hydrocarbons.	3	D
Fuji Recycle, ^h Aioi, Japan	Dedicated process unit and catalyst yield crude oil	5	C
HYDROGENATION			
UK-Wesseling, Cologne, Germany	High-pressure cracking of plastics into hydrocarbons.	3	D
ELECTROKINETIC GASIFICATION			
Mid-Ohio Technologies, Toledo, OH	Electric arcs activate free radicals, separate polymer into industrial-gas fractions.	2	D
MOLTEN METAL BATH			
Molten Metal Tech., Cambridge, MA	Polymer waste injected into metal solvent bath yields gases, chemicals, alloys.	8	C

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ADVANCED PYROLYSIS			
Wayne Tech., Victor, NY	Three-stage condensation takes plastics stream to oil.	9	D
SMC Automotive Alliance/ SPI, Washington, DC	Sheet molding compound waste is pyrolyzed into pyro-gas, oil and "char."	10	D
POLYMER DISSOLUTION^d			
Argonne Labs, Chicago, IL	Separating plastics in auto shredder residue ; realloying.	6	D
Rensselaer(RPI), Troy, NY	Fractionating mixed plastics by dissolving them in xylene ; recombination into composites.	3	D
Polytech Univ., Brooklyn, NY	Solubilization and reprocessing of cured epoxy.	10	E

a : See glossary of terms.

b : Categories are : 1=PET bottles ; 2=mixed PET ; 3=commingled thermoplastic ; 4=polyurethane foams ; 5=polyolefins ; 6=auto shredder residue ; 7=automotive seats(mixed polymers) ; 8="nuisance" plastics(medical waste, wire & cable, heavy metalcontaining product) ; 9=plastics-rich municipal solid waste ; 10=thermosets.

c : Categories are : C=commercial ; D=demonstration plant ; E=experimental.

d : Polymers yielded by polycondensation and having ester links(including polyesters, nylon and acrylic) or by reaction(polyurethane). e : Glycolysis variant.

f : Company recently acquired the reprocessed polyol line(Chardol) made by Chardonol Chemical in a process similar to that Oxid uses.

g : Polymers produced by polyaddition of molecules into chains(polyolefins, styrenics, vinyls).

h : Represented in U.S. by Fagan Technology, Furlong, PA.

i : Also termed solvent fractionation. Involves use of a chemical process to separate polymers.

A GLOSSARY OF TERMINOLOGY USED IN CHEMICAL-PROCESS RECYCLING

Coking : Refinery recycling in high-temperature, batch-process ("coker") units favored in refining heavy feedstocks.

Cracking : refinery recycling in catalytic, continuous-process ("cat cracker") units used to refine light feedstocks.

Depolymerization : processes for breaking down the typically longer, higher-molecular-weight molecules found in polymer waste to shorter, lower-molecular-weight chains for reuse as building blocks for virgin polymers.

Electrokinetic Recycling : use of an electric arc to break down plastic waste into useful industrial gases.

Glycolysis : partial breakdown in presence of glycol of reaction or condensation-type polymers into monomer, which may in turn be repolymerized.

Hydrogenation : addition of hydrogen to hydrocarbon fractions in order to create value-added chemicals.

Hydrolysis : complete breakdown in presence of water of reaction or condensation-type polymers into monomer, which may in turn be repolymerized.

Material Recycling : reprocessing of plastic into uses comparable to the original one (primary recycling) or uses requiring less demanding properties (secondary recycling).

Methanolysis : complete breakdown in presence of methanol of reaction or condensation-type polymers into monomer, which may in turn be repolymerized.

Molten Metal Bath Extraction : use of a high-temperature molten metal bath to break down polymeric chains in injected plastic waste into useful industrial gases. Contaminants in plastics may also be recovered as a metal or synthesized as a chemical.

Polymer Dissolution (Solvent Fractionation) : differential dissolving of a mixed plastic stream in selected solvents for later separation and recovery by polymer type.

Pyrolysis : decomposition of plastic waste back into oil or gas using heating processes that are free or deficient in oxygen.

Refinery Recycling : introduction of plastic waste into a refining unit so as to snap the polymer chains into lighter fractions comparable to those found in the refinery stream.

Tertiary Recycling : recovery of reusable chemical products by chemical modification of plastic waste.

(Modern Plastics Int'l, July 1991 p. 26) (KIST 한양규)